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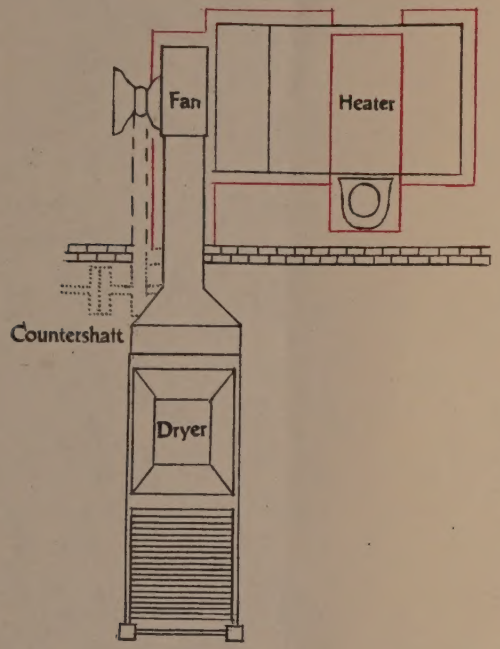
THE LAGGING OF TEA DRYERS.

Fig. I.—Sketch showing plan of E. C. P. Dryer with fan and heater outside building. Lagging is shown by red line.



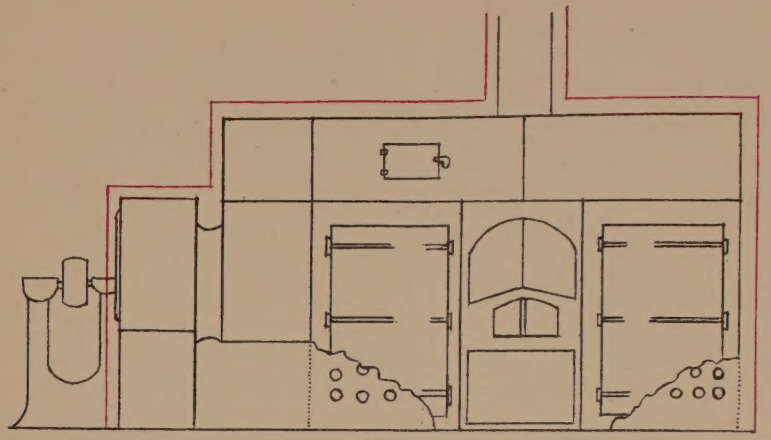


Fig. II.—Front elevation of E. C. P. heater. Lagging is shown by red line.

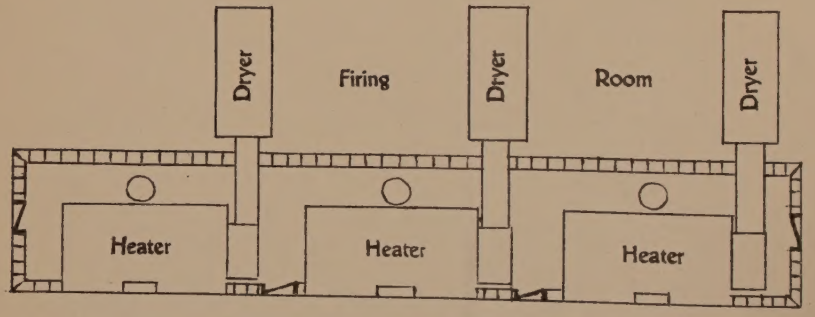


Fig. III.—Diagram showing the insulation of a range of Tea Dryers by means of a wall.

THE LAGGING OF TEA DRYERS.

BY

C. R. HARLER.

In putting down tea drying machines certain precautions should be taken regarding their location in the firing room. If possible, the stoking should be done outside the firing room. The benefit from such an arrangement, in both convenience and cleanliness, is obvious. Secondly, the machine should be placed so that it is not in a cool draught. Thirdly, care should be taken that the damp, exhaust air from the drying chamber does not find its way back into the air heater. These last two precautions make for machine efficiency.

In connection with the need for drawing the air from the outside atmosphere into the heater unmixed with the moist exhaust air from the drying chamber, the following facts are of interest. The exhaust air from a dryer shows dry and wet bulb readings of about 120°F. and 100°F. respectively. These readdings are liable to considerable variation, of course. The outside atmosphere on a normal day in the rains in North East India shows a wet bulb reading of about 80°F. and a dry bulb varying from 80°F. to 90°F. The wet bulb seldom rises above 83°F. The atmosphere in the rains thus contains from about 9 to 11 grains of moisture per cubic foot, the lower value holding with dry and wet readings of 91/81°F., and the higher with readings of 80/80°F. The exhaust air from the dryer contains about 13.5 grains moisture per cubic foot and hence, if drawn into the dryer and heated to 180°F., or whatever the initial firing temperature may be, has a much lower drying capacity than even saturated outside atmosphere when heated to 180°F.

If possible, the heater should be walled off from the drying chamber, or some arrangement made to ensure that the exhaust air finds its way easily up through the roof of the factory and not back into the heater.

Apart from the loss of efficiency through the reason just discussed, serious loss usually occurs because of heat dissipated by radiation from the heater and the air ducts. A big saving in fuel can be effected by suitably lagging these parts of the machine.

In Java it is customary to insulate the heater and air ducts with sheets of some non-conducting asbestos material such as italit, eboloeit or markinit. The first make of sheet is thin whilst the other two are thicker and more able to withstand rough usage. Other makes of sheet asbestos lagging are being tried in Assam. These substances are fixed into light iron frames about a foot away from the heater or ducts, so that the sheets can be easily removed for getting at any part of the machine. In this manner the heater is insulated by a layer of air about a foot thick and, as a result, fuel economy up to 40% is claimed in some cases, whilst a saving of 25% is possible in practically any factory.

If all the drying machines in North East India were so lagged at a saving of 25% in the fuel bill, it is estimated that, on a crop of 320 million lbs., a saving of Rs. 10 lakhs per annum would be made. This assumes that one maund of coal, costing one rupee, is required at present to dry one maund of tea. The initial cost of installing such a lagging system is about half the saving made in one season.

Lagging on the lines followed in Java has been put into practice in one factory in North Lakhimpur, with a resultant saving in fuel of more than 25%. If the heater happens to be in a particularly draughty position the saving will be greater, whilst in a room where the air movement is restricted it will probably be less than 25%.

An effective scheme of air lagging has been carried out in a Doom Dooma garden in the following manner. The heaters of three E. C.P. machines which are in line, are completely surrounded by brick walls a few feet higher than the heaters. On top of the wall is a roof of corrugated iron. One wall runs flush with the front of the heaters, leaving the furnace doors and the

tube inspection doors on either side, exposed. Wings at the ends of the line of heaters isolate the stoking from the factory. Through the wall along the back of the heaters the air ducts pass to the three drying chambers. At the sides and behind the heaters there is just sufficient room for a man to pass between heater and wall. In the latter, inspection doors, which may be opened to let in extra air to the heaters, are placed in convenient positions. Between the top of the wall and the roof there is also space for air to enter and find its way to the heaters. The arrangement is indicated in the accompanying diagram (*Fig. III*).

As a result of this insulation the fuel consumption has been reduced to two-thirds its former figure.

Whilst the above system of lagging is cheap and efficient for a range of dryers conveniently put down in line, it usually happens that in most factories it is necessary to lag single dryers often situated well within the firing room. The sketches opposite (*Figs. I and II*) offer suggestions as to how this may be carried out with the E.C.P. type of heater, along the lines followed in Java. It will be observed that the intake air passes across the top and round the sides of the heater before passing over the hot tubes to the fan. The air when it enters the actual heater has thus been warmed, which effects an economy in addition to that resulting from the reduction of loss of heat by radiation due to the lagging.

The air lagging may or may not include the front of the heater where the stoking is done. Care must be taken to ensure that the air inlet, on top of the stove, is at least equal in area to the sum of the areas of the two side air inlets and the inlet by the chimney of the unlagged stove.

Messrs. The Planters' Stores, of Calcutta, have designed a suitable steel framing for E.C.P. Dryers, and Messrs. Bell's Asbestos and Engineering (India), of Calcutta, supply Magnesia-Asbestos blocks of one inch thickness to fit the frame-work. The ex-godown cost of the framing and insulating material is

Rs. 600/- for the small and Rs. 825/- for the big E.C.P. Dryer.

In air lagging heaters of the "Empire" type, the face carrying the air tubes presents some difficulty owing to the fact that if the whole of the heater is enclosed in a casing of asbestos, there will be some risk of starving the tubes of air, wherever the air intake may be placed. Complete air lagging in such cases is a matter for experiment. The heater, less the face carrying the air tubes, may be air lagged, but the saving in this case will not be so great as in the case of the E.C.P. stove since no air movement within the lagging will be possible.

THE INTRODUCTION OF A YEAR OF UNPRUNED IN THE BUILDING UP OF A YOUNG BUSH.

BY

C. J. HARRISON.

The use of unpruned mature tea offers certain advantages particularly to short laboured gardens, but suffers from grave disadvantages which render its frequent use undesirable.

Firstly, pruning in the subsequent year to leaving unpruned means cutting on two-year old wood, which is thicker and harder than one-year old wood, leaving wounds which do not readily heal over and may become points of attack for fungus diseases. Furthermore new shoots do not come away from close to the cut so readily on two-year old wood, and a large number of dead snags may result after pruning.

Moreover, after pruning in the year before leaving unpruned, a certain number of snags must necessarily occur, and whereas these would normally be removed in the following year's pruning, they remain for two years on the bush if the latter is left unpruned, and introduce a much greater risk of fungal infection.

Another disadvantage arises from the fact that the root system of a bush develops sufficiently to provide water and plant food for the leaf growth during the rains when the soil moisture is high. When the soil dries out, the root system is insufficient to provide water for the leafy top of the bush which is continually losing water through transpiration. Normally, this disturbance of balance between leaf and root is partially or wholly restored by removing the major part of the leaf area by pruning. When large bushes are left unpruned, particularly under dry cold weather conditions, much die back occurs, on account of insufficient water supply to the leaves.

A mature bush, surrounded by equally large bushes, has little room in the soil for root expansion, and when left unpruned, restoration of the balance by enlarged root system is to any appreciable extent impossible.

This is clearly demonstrated in an experiment (1) on the Tocklai clearance on which some plots have been annually and some biennially pruned for ten years. During the first five years, the tea unpruned in alternate years gave an increased average crop over the annually pruned tea. During the latter five years, deterioration has set in so that the average crop is now below that of the annually pruned tea. The actual crop figures for the two 5-year periods are as follows :—

TABLE I.

Crop in mds. tea per acre from the Tocklai clearance.

	Annually pruned.	Biennially pruned.
1920—1924	50·44	55·31
1925—1929	62·44	55·48

In the case of a young and vigorous bush, the defects of leaving the bush unpruned are less likely to be so marked as on older tea. The damage resulting from dead snags will be less if the bush is pruned for two years following the year of leaving unpruned, thus removing all dead wood. Furthermore the large wounds left after cutting on two-year wood are more likely to heal up since they are made on the more vigorous branches of the young plants.

In the case of young bush full of vitality and with plenty of room for root expansion in the soil, the disturbance of balance between roots and leaves caused by leaving the bush unpruned is likely to be corrected by growth of new roots. In fact, leaving the young bush unpruned is likely to be a means of forcing an extended root system and of assisting in the development of a larger and stronger bush.

Comparatively recent work has to a great extent modified previous ideas on the pruning of young trees. The following remarks are quoted from an article (2) describing experiments on pruning young fruit trees.

"In particular, it has shown that the vigorous growth which follows heavy pruning is largely devoted to replacing what was

taken away, and the net gain is much less than it would have been had no pruning been done"; and "pruning temporarily stimulates growth. This stimulative effect lasts until balance between root and top is re-established. For the most part, this growth stimulation is evident in the immediate vicinity of the pruning cut. In reality, however, the tree is dwarfed in proportion to the severity of the pruning treatment, because the new growth produced by the pruned tree is not enough greater than that produced by the unpruned tree to compensate for what is removed in pruning." Thus it would seem that the amount of pruning done on a young bush should not be more than is necessary to establish a strong framework capable of bearing the maximum plucking area. Too much pruning in its early life, may result in a dwarfed bush, and for this reason it would be better to underprune rather than overprune.

From these considerations leaving young tea unpruned for a year is very likely to prove better than annual pruning. A trial was made at Borbhetta to test this point.

A clearance of New Rajghur tea was put out from a year-old nursery in November 1924. It was low centred a year later and plucked at 30" from the ground during 1926. In part of the clearance, alternate lines were left unpruned in 1927 and plucked at about 36" from the ground, while the intermediate lines were pruned to 12"-15" from the ground and plucked at 30". Since then pruning and plucking have been the same for both sets of lines, *i.e.*, to 18" before the 1928 season, to 20" before the 1929 season, and to 22" before the 1930 season. The yields to date have been :—

TABLE II.

Maunds tea per acre.

	Annually pruned.	Unpruned in 1927.
1927	4·27	8·44
1928	6·06	6·52
1929	9·46	10·62
TOTAL ...	19·79	25·58

Apart from the gain in crop, the bushes left unpruned in 1927 have a definitely healthier appearance, with greater spread than the annually pruned tea.

In both cases cuts on wood up to ¾″ thick have callused over completely. Whereas on the annually pruned tea there were practically no cuts on wood thicker than about ¾″, cuts up to 1½″ had to be made on two-year old wood on the bushes unpruned in 1927 and these cuts are as yet not entirely protected by callus growth. If disease has entered, however, it cannot have penetrated far, and no apparent damage has yet resulted.

It is evident that two-year old wood on young tea is not as hard as similar wood on older tea, so that the risk of cuts not callusing successfully is less in the former case. Big cuts, over 1″ in diameter were made only where the bush had thrown a very strong centre shoot again, the year after the first centre prune, and seldom was there more than one big cut on one bush.

A method which has proved successful for building up a bush is as follows, and is the method employed in the trial described above.

First year after planting. Cut out centre stem flush with a side branch, leaving at least two side branches, more if possible The cut should be not more than 9″ from the ground. Any very strong growing side branch may be headed back. If there are less than two side branches below 9″ then cut the bush 6″ from the ground. Tip at 30″ from the ground.

Second year after planting. Leave the bush unpruned, except for removal of any very strong-growing perpendicular centre shoots, and pluck at about 36″ from the ground.

Third year after planting. Prune at 12″-15″ from the ground, cutting each branch to an outside eye. Take out any strongly growing perpendicular centre shoots, leaving no snag. Pluck to 30″ from the ground.

Fourth year after planting. Prune at 18″ from the ground, again cutting to an outside eye. Again pluck to 30″ from the ground.

Fifth year after planting. Prune to 20″ from the ground. Again pluck to 30″.

Following years. Prune to two fingers of new wood above highest pruning of previous year. Pluck to an 8″ or 6″ measure.

SUMMARY.

1. Decreased tendency for large cuts on wood over two years old to heal up, and loss of balance between root and leaf systems during dry soil conditions militate against the success of unpruned tea.

2. These disadvantages are considerably less in the case of very young tea which may be left unpruned the year after centring, thereby improving the health of the bush and increasing the spread.

3. Leaving such tea unpruned tends to encourage root growth to restore the loss of balance between root and leaf, and hence to increase the strength of the bush.

4. Pruning tends to lessen the ultimate size of the bush, and in early years should be sufficient only to produce a strong and suitable frame.

5. In the experiment at Borbhetta cuts less than ¾″ diameter healed completely. Cuts over 1″ remained uncallused, but disease if it has entered does not appear to have penetrated deeply.

6. More total crop was obtained even after 3 years, by leaving unpruned for one year.

7. Plucking must be light, both before and during the unpruned year, *e.g.*, 30″ from the ground before, and 36″ from the ground when unpruned.

REFERENCES :—

(1) The Tocklai Clearance, C. J. Harrison, *Quarterly Journal,* I.T.A. pt. I, 1929.

(2) Pruning young fruit trees, R. E. Marshall, H. A. Cardinell, and H. D. Hootman. *Circular Bulletin No. 127*. Agri. Exp. Stn. Michigan State College.

SOME OBSERVATIONS ON TEA LEAVES.

BY

A. C. TUNSTALL.

If the individual bushes in a section of tea are plucked separately, it is at once apparent that some of them are yielding much more than others, although the general appearance, size, etc., of the low yielding bushes may be similar to that of the high yielding ones. If it were possible to ascertain the characteristics associated with high yielding propensities it may be possible to select the most promising plants in the nurseries, discarding the remainder. It may also be possible to raise the percentage of good plants in the nurseries by careful selection of the seed bearing trees. It may be pointed out that immunity to disease is not necessarily associated with high yield. High yielding capacity is however, the first consideration from the practical point of view. Disease is only important in so far as it reduces the yield. In the course of the observations made with a view to selecting high yielding strains it is hoped that methods for the selection of disease-free strains will be developed. These methods may then be applied where circumstances render their application desirable.

Dr. Cohen Stuart in Java has, for a considerable period, carried on research in the selection of pure strains of tea. His latest work, however, appears to indicate that high yield is not necessarily associated with purity of strain. The conditions in North East India differ from those in Java, and it is unwise to accept the conclusions drawn from observations in that country as applicable to our conditions. One difference was at once obvious. Dr. Cohen Stuart observed differences in the length of the point at the apex of the leaf. At Tocklai the points are in all cases so short that the probable error in their measurement would make it necessary to make very large numbers of observations before any significant result could be expected. From preliminary observations it was obvious that whatever characteristics were chosen it was necessary to make a large number of observations

before any conclusions could be drawn. As our object was primarily to ascertain characteristics which were associated with high yield it was necessary to deal with pruned and plucked bushes. This made it impossible to consider the habit of branching of the stems. Numerous observations on the roots showed that the soil and not any inherent quality in the bushes concerned determined the shape of the roots. The observations were therefore confined to the leaves. The leaves from pruned and plucked bushes were first observed. The work was then extended to seed trees, and subsequently to the seedlings from the seed trees concerned. A further set of observations is now being made on 100 individual plucked bushes and observations on the microscopic structure of the conducting tissues of the leaf stalks, the lengths of internodes and leaf stalks, the area of leaves and the yield per bush have been added to the observations recorded previously. So far the work has involved the observations of about 40,000 individual leaves, but it is still too early to draw very definite conclusions.

In 1926 the writer measured the length, breadth, number of principal veins and number of serrations of leaves grown on the plucked plots adjoining the laboratory at Tocklai. There are thirteen plots.

Assam indigenous type.	Singlo from plants grown from jungle seed. Kharikatia from plants grown from Singlo seed. Betjan from plants of Assam indigenous origin.
Burma type.	Burma from jungle seed direct from Burma. Kalline from plants grown from jungle seed. Panighat from plants of Burma origin.
China type.	From plants said to be the progeny of seed obtained direct from China many years ago.

In each of the above, except Burma, there were two similar plots one of which is pruned in alternate years and the other pruned annually. At the time the observations were made the biennially pruned plots were unpruned. The annually pruned Burma plot had unfortunately been removed to make room for a new laboratory.

For purposes of the experiment 100 bushes were selected from each plot. From each of these bushes five leaves were taken, once at the beginning of the plucking season and again at the end. The leaves selected were in each case fully grown leaves on actively growing shoots. Care was taken to avoid taking leaves from *banji* shoots. In this manner two lots of 500 leaves were obtained from each of the 13 plots.

The arithmetic means of the various observations are recorded in the tables given below.

Arithmetic means of length of leaves in m.ms.

Type.	Name.	Unpruned.		Pruned.	
		Early in season.	Rainy season.	Early in season.	Rainy season.
Assam	Singlo	128·10±·38	128·10±·38	146·58±·55	112·62±·40
	Kharikatia	130·38±·42	120·94±·40	148·66±·53	118·6 ±·41
	Betjan	141·16±·48	126·26±·36	156·78±·39	110·84±·36
Burma	Burma	114·84±·45	120·46±·56		
	Kalline	124·54±·45	94·94±·31	137·00±·45	108·24±·36
	Panighat	131·04±·43	112·52±·45	142·2 ±·40	101·54±·33
China	China	103·84±·40	86·16±·33	110·04±·46	92·20±·36
Average excluding Burma plot.		126·51	118·15	140·21	107·34
		122·33		123·77	

Arithmetic means of breadth of leaves in m.ms.

Assam	Singlo	49·66±·16	49·66±·16	57·04±·22	45·20±·15
	Kharikatia	50·30±·19	47·44±·15	60·94±·22	47·23±·16
	Betjan	55·50±·19	46·71±·14	66·45±·18	49·87±·16
Burma	Burma	44·81±·16	46·30±·18		
	Kalline	46·54±·15	39·48±·11	56·83±·21	43·57±·13
	Panighat	49·06±·17	44·46±·15	59·10±·20	42·62±·13
China	China	38·63±·16	34·56±·13	46·43±·20	37·64±·15
Average excluding Burma plot.		48·28	43·72	57·79	44·34
		46·00		51·06	

Arithmetic means of total number of serrations on each leaf.

Type.	Name.	Unpruned.		Pruned.	
		Early in season.	Rainy season.	Early in season.	Rainy season.
Assam	Singlo	85·86±·43	87·24±·48	108·82±·55	96 24±·50
	Kharikatia	86·86±·44	86·04±·47	111·50±·51	99·28±·52
	Betjan	90·08±·48	80·96±·44	100·68±·51	90·82±·46
Burma	Burma	71·64±·45	78·16±·45		
	Kalline	76·52±·36	76·74±·42	93·78±·54	82·10±·42
	Panighat	75·75±·38	72·60±·39	92·70±·40	81·66±·40
China	China	67·96±·47	62·82±·48	81·80±·53	71·38±·43
Average excluding Burma plot.		80·50	77·73	98·21	86·91
		79·12		92·56	

Arithmetic means of numbers of principal veins on one side of leaf.

Assam	Singlo	13·450±·05	11·77±·04	12·390±·05	10·980±·05
	Kharikatia	13·632±·04	11·97±·04	12·520±·05	10·990±·04
	Betjan	13·470±·05	10·99±·04	12·238±·05	10·280±·04
Burma	Burma	11·898±·04	11·11±·05		
	Kalline	12·614±·05	10·40±·03	11·416±·04	9·906±·03
	Panighat	13·187±·05	11·77±·04	12·304±·04	10·252±·04
China	China	11·000±·05	9·42±·04	9·900±·04	8·430±·03
Average excluding Burma plot.		14·55	11·05	11·79	10·14
		12·80		10·97	

For comparison with the above figures similar observations were made on unplucked tea plants in 1928. The leaves selected in this case were mature ones which had fallen naturally from the plants concerned. The observations were limited to nine trees each of Burma and Kharikatia respectively. These trees were planted at the same time and from the same nurseries as the plucked plots mentioned above: 300 leaves were selected from each tree, making a total of 2,700 leaves for each group. The trees were in adjoining lines with lines of other tea trees adjoining them on both sides. The conditions of growth of the two groups may therefore be considered to be as similar as possible.

The results of these observations are recorded in the following table.

Type.	Plot.	Serrations.	Veins (one side only)	Length in m.ms.	Breadth in m.ms.
		Arith. mean.	Arith. mean.	Arith. mean.	Arith. mean.
Burma ...	Burma ...	49·00±·15	10·40±·01	89·51±·17	33·92±·06
Assam ...	Kharikatia...	67·13±·16	10·48±·01	88·01±·18	36·18±·07

It will be noticed that the results differ considerably from those obtained from plucked bushes. The only striking difference between the leaves from unplucked and unpruned Assam indigenous and Burma trees is the number of serrations.

A further set of observations was obtained in the same year by taking the seed from each of the unplucked trees mentioned above. The seed was planted without previous germination in adjoining beds. The seedlings were all dug up when the largest ones had produced four or five leaves. The length, breadth, number of veins and number of serrations on each of the leaves of the seedlings were recorded.

It was noticed that the leaves on individual seedlings differed from each other. For instance, the first leaf from the ground was always much smaller than the subsequent leaves. It was also noticed that the first leaf of a seedling having, say four leaves differed from one having a fewer number of leaves. It was therefore obvious that in order to obtain truly representative figures it was necessary to treat the figures for the various leaves separately. A weighted average was then obtained in which the measurements for each type of leaf had an equal influence. In the case of each lot of seedlings the leaves were divided as follows :—

1st leaf of seedling having only 1 leaf.
,, ,, ,, 2 leaves.
,, ,, ,, 3 leaves.
,, ,, ,, 4 leaves.
2nd leaf ,, ,, 2 leaves.
,, ,, ,, 3 leaves.
,, ,, ,, 4 leaves.
3rd leaf ,, ,, 3 leaves.
,, ,, ,, 4 leaves.
4th leaf ,, ,, 4 or more leaves

As seedlings bearing five leaves were few in number, the 5th leaf was not considered. Frequency tables were prepared for each of the above. The tables for each group were reduced to 100. These were then added together in the following ways.

1. All the first leaves of each lot.
2. All the second leaves.
3. All the third leaves.
4. All the above with the fourth leaf.

The arithmetic mean of these was then worked out.

As the difference between the arithmetic means of the parent's leaves is only marked in the case of their serrations only those results are shown in the following tables :—

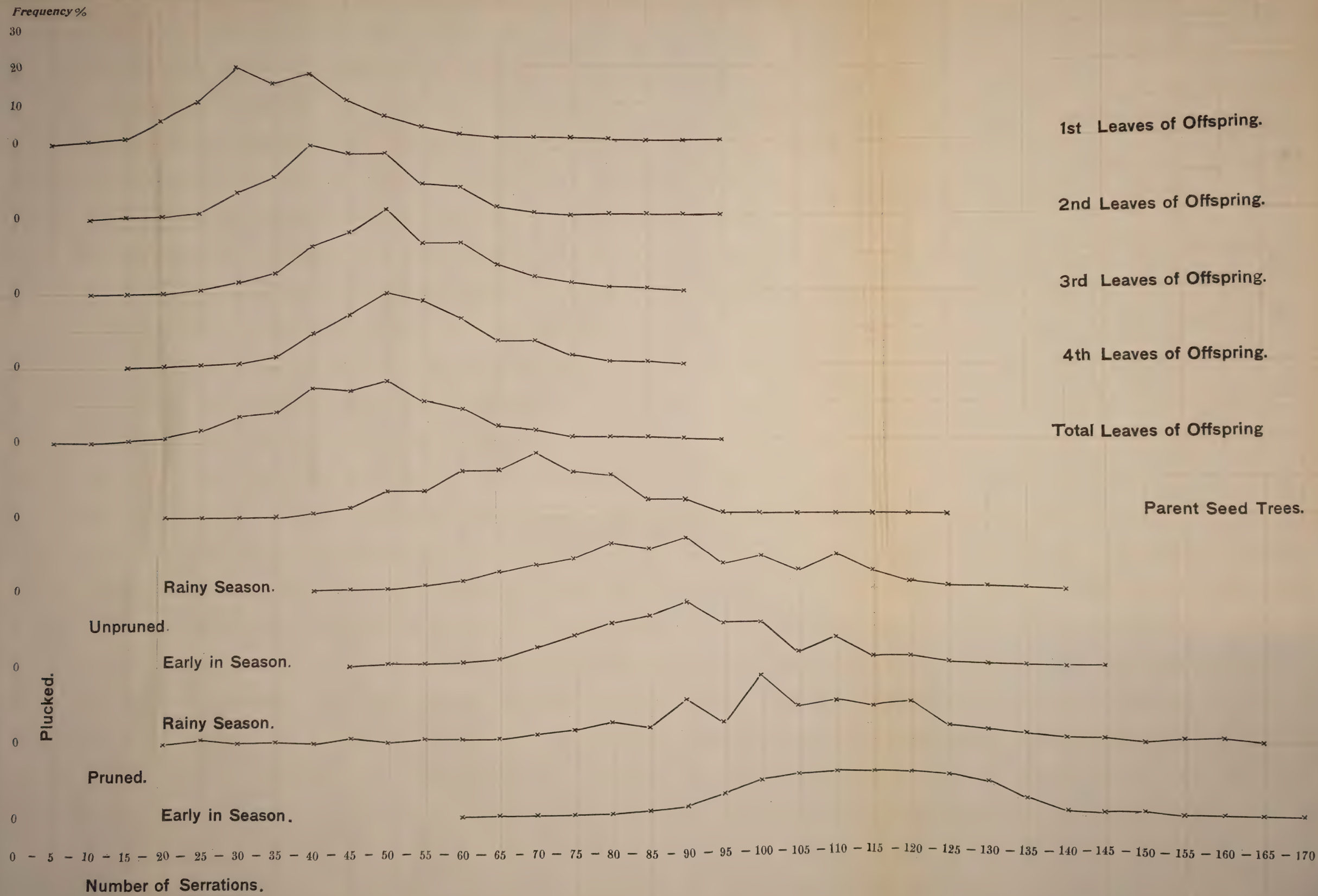
BURMA TYPE. NUMBER OF SERRATIONS

No. of seed tree	Parent.	Offspring.									
	Arith. mean of 300 leaves each.	1st leaf		2nd leaf		3rd leaf		4th leaf		Weighted totals. Arith. mean.	Total No. of leaves.
Burma.		Arith. mean.	No. of leaves.	Arith. mean.	No. of leaves.	Arith. mean.	No. of leaves.	Arith. mean.	No. of leaves.		
A	60·15	31·41	234	46·18	234	44·77	168	49·15	59	42·88	695
B	43·80	30·31	447	39·95	396	46·07	283	48·30	98	41·16	1,224
C	58·00	35·21	815	44·46	741	50·20	479	48·62	129	44·62	2,164
D	43·86	30·17	1,111	37·53	1,042	43·18	771	44·03	303	38·73	3,227
E	48·30	32·52	702	41·28	629	45·42	412	47·40	132	41·65	1,875
F	34·75	29·65	35	39·42	34	46·23	24	47·65	12	40·74	105
G	54·25	35·16	213	44·59	196	49·03	139	46·70	54	43·87	602
H	49·76	31·85	622	38·31	573	42·90	391	45·01	133	39·52	1,719
I	48·15	29·04	347	38·10	312	43·05	200	45·10	53	38·82	912
Average.	49·00	31·77	4,526	41·09	4,157	45·65	2,867	46·88	973	41·33	12,523

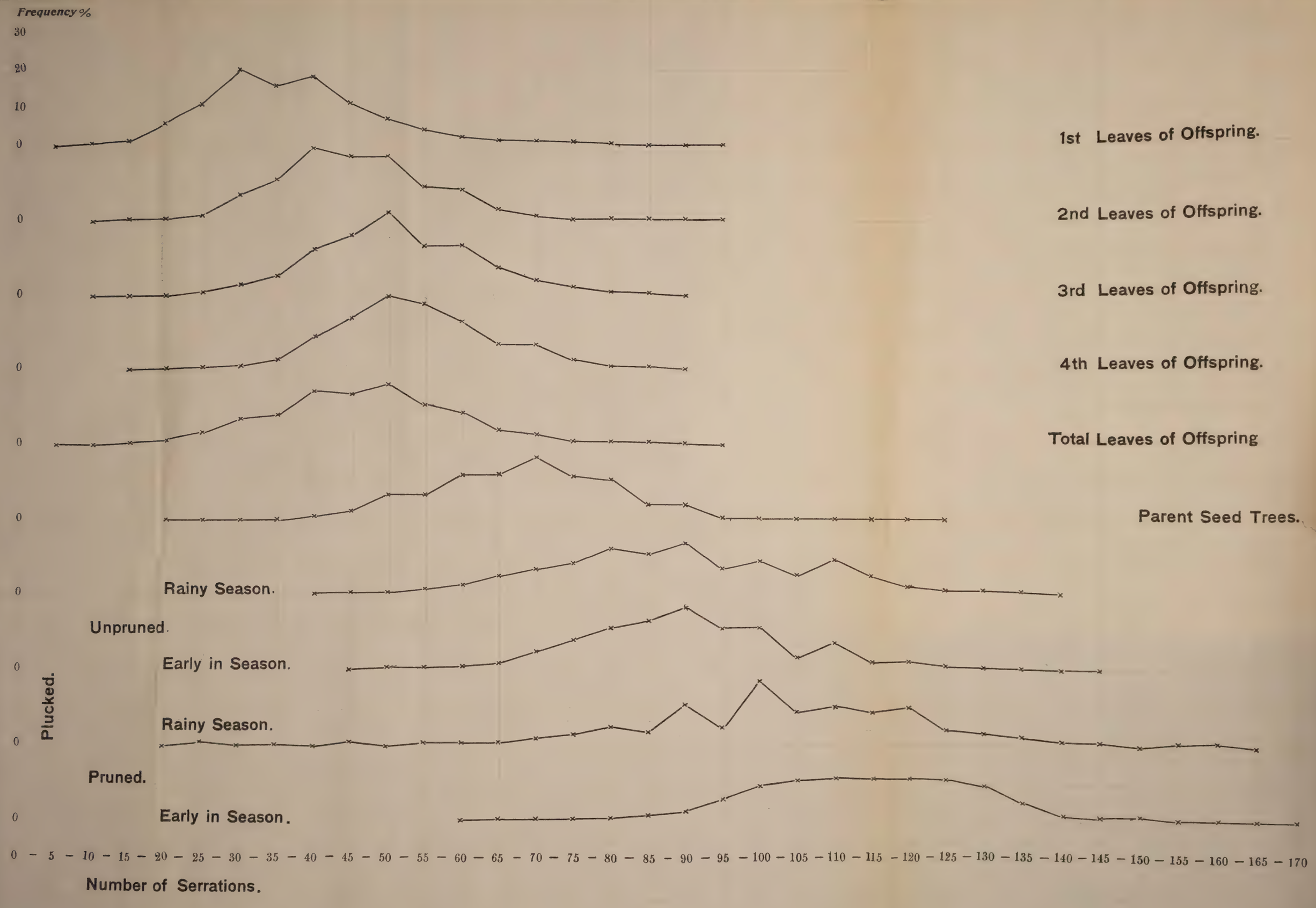
ASSAM TYPE.

Kharikatia.											
A	62·66	29·40	367	40·09	347	44·13	248	44·88	77	39·62	1,039
B	57·35	32·55	1,050	43·34	967	48·58	649	50·70	219	43·76	2,885
C	73·51	35·88	383	45·35	312	49·73	247	51·06	88	45·50	1,030
D	70·50	34·61	543	44·60	518	51·33	367	53·93	140	46·11	1,568
E	72·50	38·54	307	48·68	284	55·64	217	56·82	104	49·92	912
F	66·41	34·43	245	46·12	226	52·67	167	54·00	60	46·80	698
G	72·90	33·22	83	39·64	79	44·33	61	44·61	28	40·45	251
H	60·61	31·76	187	39·43	174	44·70	129	44·98	62	40·96	552
I	67·44	32·00	364	39·46	331	44·05	218	44·76	76	40·56	989
Average.	67·15	33·59	3,529	42·96	3,238	48·57	2,303	49·86	854	43·74	9,924

ASSAM TYPE.


Frequency %
30
20
10
0
0
0
0
0
0
1st Leaves of Offspring.
2nd Leaves of Offspring.
3rd Leaves of Offspring.
4th Leaves of Offspring.
Total Leaves of Offspring
Parent Seed Trees.
Rainy Season.
Unpruned.
Early in Season.
Rainy Season.
Pruned.
Early in Season.
Plucked.
0 – 5 – 10 – 15 – 20 – 25 – 30 – 35 – 40 – 45 – 50 – 55 – 60 – 65 – 70 – 75 – 80 – 85 – 90 – 95 – 100 – 105 – 110 – 115 – 120 – 125 – 130 – 135 – 140 – 145 – 150 – 155 – 160 – 165 – 170
Number of Serrations.

ASSAM TYPE.


Frequency %
30
20
10
0
1st Leaves of Offspring.
2nd Leaves of Offspring.
3rd Leaves of Offspring.
4th Leaves of Offspring.
Total Leaves of Offspring
Parent Seed Trees.
Rainy Season.
Unpruned.
Early in Season.
Rainy Season.
Pruned.
Early in Season.
Plucked.
0 – 5 – 10 – 15 – 20 – 25 – 30 – 35 – 40 – 45 – 50 – 55 – 60 – 65 – 70 – 75 – 80 – 85 – 90 – 95 – 100 – 105 – 110 – 115 – 120 – 125 – 130 – 135 – 140 – 145 – 150 – 155 – 160 – 165 – 170
Number of Serrations.

The similarity between the parents and their offspring is much more clear in the frequency curves. The frequency curves for the offspring of individual trees (not reproduced) also show a marked similarity between the leaves of the parent and those of its offspring. For comparison the frequency curves of the number of serrations on the plucked bushes are also reproduced. The similarity between the leaves of the parent trees and of their offspring is greater than that between the former and the leaves of plucked bushes obtained from the same nurseries. From a study of the curves, it seems probable that if a greater number of leaves of the offspring than four had been observed the frequency curve for the offspring would have coincided with that of the parents still more closely.

It should be noted that the parent trees of both types were adjoining each other and those of other types. No attempt was made to prevent cross fertilisation between the types. All endeavours to prevent cross fertilisation by bagging the flowers have failed at Tocklai as in every case, the fruits fell prematurely. It was later ascertained by experiment that well formed immature fruits failed to mature when enclosed in fine muslin bags. This was found to be the case even when the bags were large enough to enclose the whole of the branch concerned. The premature fall of the fruit could not in this case be due to failure in fertilisation. It appears to be caused by the excessive humidity of the air within the bags.

As labour and market conditions become more difficult it is increasingly important to obtain high yields per acre thus reducing the cost per pound of tea both in labour and money. The selection of new strains involves observations over a long period and it is unlikely that any spectacular results will be obtained in the near future. These investigations are being continued as time permits, and the above results will be discussed in a latter article.

TEA IN RANCHI AND DEHRA DUN.

BY

C. R. HARLER.

Ranchi and Dehra Dun are small tea districts far removed from the main tea area of North East India. They are, however, centres of considerable interest, because climatic conditions are much more difficult than at Jalpaiguri, Chittagong, South Sylhet and the Terai, which districts are considered to be, climatically, the most unfavourably situated in North East India.

The area under tea in Ranchi is about 1,800 acres, and in Dehra Dun about 5,500 acres. There are a few acres (less than 20) under tea near Hazaribagh, which area is included in the Ranchi figure, and about 200 acres in the Kumaon district, near Dehra Dun.

In the whole of India there are 773,023 acres reported under tea, of which 705,688 acres were plucked in 1928. This latter acreage is made up as follows :—

Brahmaputra Valley	262,905	acres.
Surma Valley	144,982	,,
Dooars and Darjeeling	178,440	,,
Chittagong	4,844	,,
Ranchi	1,836	,,
Dehra Dun and Kumaon	5,770	,,
Kangra Valley	9,681	,,
South India	97,230	,,
	705,688	,,

Climates of Ranchi and Dehra Dun.

Ranchi is about 400 miles west of Chittagong, on the opposite side of the Bay of Bengal, about 150 miles from the coast. It is not situated within the track of the moist air drift which passes into

References—Bihar & Orissa District Gazetteers, Ranchi, 1917.

United Provinces District Gazetteers, Dehra Dun, 1910.

The Geography and Geology of the Himalaya Mountains and Tibet, Burrard, S. G. and H. H. Hayden, Calcutta, 1907 and 1908 (pts. 1—4).

North East India, bringing early rain and lowering the temperature in the spring months. The climate of Ranchi is hence dry and hot before the arrival of the Monsoon, and resembles that of Calcutta.

Dehra Dun is situated at the western end of Nepal, about 650 miles north-west of the Bengal Terai and about 800 miles from the Bay of Bengal and the Arabian Sea. Its proximity to the Himalayas profoundly influences the Dehra Dun climate, making it cooler and more humid than that of the plains a few miles distant. Dehra Dun receives part of its monsoon rain from the Bengal current and part from the current coming from the Bombay side.

The table below shows the rainfall at Ranchi and Dehra Dun together with that of Chittagong and the town of Jalpaiguri. These last two represent, climatically, the most difficult tea areas in North East India. The table also includes the Tocklai rainfall as being indicative of conditions in Middle Assam.

Table showing rainfall.

Month.	Ranchi.	Dehra Dun.	Chittagong.	Jalpaiguri.	Tocklai.
	ins.	ins.	ins.	ins.	ins.
January ...	0·63	2·19	0·28	0·30	0·93
February ...	1·24	2·49	1·03	0·66	1·47
March ...	1·10	1·46	2·56	1·36	3·43
April ...	0·80	0·78	5·47	3·73	7·75
May ...	2·33	1·57	9·52	11·07	9·09
June ...	9·00	8·29	20·79	23·73	13·51
July ...	14·46	24·33	22·40	31·24	16·14
August ...	13·61	25·68	19·30	25·04	13·16
September ...	8·23	9·30	11·93	19·94	11·29
October ...	2·79	0·29	6·88	4·90	4·87
November ...	0·37	0·92	1·70	0·20	0·97
December ...	0·16	0·67	0·70	0·11	0·30
Total	54·72	77·97	102·73	122·32	82·51
No. of wet days	81	79	95	103	118

Points to observe in the Ranchi and Dehra records are the dry spell from March to May, and the late arrival and early close of the Monsoon. The winter rainfall in Dehra is more than that in Assam.

The next table shows the average monthly maximum and minimum temperatures, and the average monthly relative humidities, taken at 8 *a.m.*, recorded at the same stations as in the first table.

Table showing temperatures and humidities.

	Ranchi.			Dehra Dun.			Chittagong.			Jalpaiguri.			Tooklai.		
	max.	min.	R.H.	max.	min.	R.H.	max.	min.	R.H.	max.	min.	R.H.	max.	min.	R.H.
	°F.	°F.	%	°F.	°F.	%	°F.	°F.	%	°F.	°F.	%	°F.	°F.	%
January ...	74	51	65	66	45	78	78	55	88	73	51	91	72	49	95
February ...	77	55	60	69	47	72	82	59	83	76	53	85	74	52	94
March ...	87	64	45	80	55	58	87	67	82	85	60	76	80	59	86
April ...	96	72	42	91	64	46	89	73	80	90	68	75	82	66	87
May ...	99	76	51	95	71	45	89	75	81	89	72	83	86	71	86
June ...	92	76	72	93	74	64	87	77	86	88	76	89	90	76	86
July ...	84	73	88	86	74	85	86	77	88	88	77	91	90	77	89
August ...	84	73	89	84	73	91	86	76	88	88	77	92	89	76	90
September ...	84	72	84	84	70	83	87	76	88	88	76	90	90	76	90
October ...	83	66	70	82	61	68	87	73	89	86	70	87	87	70	90
November ...	78	58	63	75	52	71	83	66	88	82	61	84	82	60	94
December ...	73	51	64	69	46	74	78	58	89	76	53	87	75	50	95

Day temperatures of about 85°F. and a high humidity are necessary to make tea flush freely. Low humidity during the growing period causes the bush to stop flushing and may even kill off the young growth. In the above table will be observed the very low humidities recorded at both Ranchi and Dehra Dun during the critical spring months of March, April and May.

In Ranchi, humidities as low as 20%, are at times registered during the day time in May, and temperatures as high as 110°F. are not uncommon. Before the Chota Nagpur plateau was deforested, it is probable that the humidity was higher, but rainfall records show no appreciable change since deforestation began.

The Siwalik Hills have a beneficial influence on the atmospheric humidity in Dehra Dun, for the drying winds which come across the plains pick up moisture and are cooled in crossing the jungle covered hills, before they enter the valley.

In both Ranchi and Dehra Dun frosts are common in January.

Tea in Ranchi.

The Ranchi tea gardens are situated on the Chota Nagpur plateau, near the town of Ranchi. This plateau is part of the geologically ancient Deccan plateau of peninsular India, and the rocks are mainly crystalline schists, quartzites, gneisses and granites of the Archaean age. The Ranchi plateau is about 2,000 ft. above sea level.

Between the Ranchi and Hazaribagh districts runs the Damuda Valley. When the coal fields in this area were developed, a need for pit-props was created which led to the wholesale deforestation of the Chota Nagpur plateau. The probable effect of this on the climate has been mentioned.

Tea was first planted in the Ranchi district at Hotwar and Palandu in 1862. The acreage at first rose steadily to about 2,300, but for the past 20 years a gradual decrease has taken place. It is almost impossible to put out fresh tea or to infill vacancies with success in the Ranchi district nowadays. Only under dense shade, like that given by mango trees, will infillings grow, and then not in a manner to yield well. Deforestation is held to be responsible for the failure of new areas and, accordingly, Ranchi tea may be expected eventually to disappear.

The jat of tea grown in Ranchi is China. Assam bushes are unable to withstand the climate, but Indo-China bushes are being tried as an experiment. The average yield is about 160 lbs. per acre, although good sections may yield up to 400 lbs.

The area under tea consists of a number of detached gardens, of about 100 acres each, which are amalgamated into groups sending leaf to a central factory. Such a group of five gardens makes up Palandu and another group of seven gardens, Sabaya, two divisions of the Assam Frontier Company. The Piska Tea Concern is another group of gardens. Two or three small gardens are run individually.

The tea soils of Ranchi.

The Ranchi soils are sandy loams of a lateritic nature. They are generally poor in organic matter and plant food compared with soils of similar texture in Assam, and are moderately acid. The average total nitrogen content is about 0.07%, the available phosphoric acid about 0.01% and available potash about 0.015%. The available lime varies from 0.05 to 0.10%. Samples of soil collected from the Palandu and Sabaya gardens were almost neutral in reaction, owing to previous heavy liming. Mahilon, a garden in the Palandu Division, which had not been limed, showed an acidity (Hopkin's method) of 176, which, though low, is well within the range of acidities of good tea soils.

The table below shows the mechanical analyses (Hall's method) of soils from various gardens in the Ranchi district. The soil fractions are percentages given to the nearest unit.

Ranchi tea soils.

Garden.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ignition.	Hopkins acidity.	pH value.
	%	%	%	%	%	%		
Palandu Divn.								
Katanga No. 2 ...	33	24	22	7	10	2·84	21	6·0
Bergaon No. 2 ...	33	32	17	6	7	1·82	14	6·4
Palandu No. 3 ...	25	22	28	9	11	2·95	21	5·7
Churoo No. 4 ...	30	24	19	9	13	2·75	28	5·8
Mahilon No. 8 ...	25	37	18	5	11	2·13	176	5·1
Sabaya Divn.								
Sabaya No. 2 ...	25	47	11	6	10	2·23	18	6·0
Mohespur ...	36	35	10	6	10	2·36	18	6·1
Anondi ...	24	41	11	7	14	3·90	28	5·9
Getalsudh ...	29	35	16	6	9	2·86	14	6·2
Mesra ...	34	38	11	7	8	2·22	25	5·9
Piska Divn.								
Lodhama ...	27	21	14	6	22	5 2	...	...
Dharamkhal ...	26	25	16	6	15	5·2	...	...
Daladeri No. 1 ...	5	26	24	15	17	8.51	...	...
„ No. 3 ...	30	33	13	7	10	1.72	...	...

In the manurial treatment of all these soils, alkaline manures *e.g.*, basic slag, calcium cyanamide, and lime should be avoided. Nitrogen is best added in the form of sulphate of ammonia, which is acid.

Field methods in Ranchi.

For climatic reasons methods in Ranchi differ considerably from those in North East India. The difficulty, in fact almost impossibility, of putting out nurseries in Ranchi has already been mentioned. If a plant is established it comes into ordinary bearing in 8 to 10 years.

The bushes are pruned every third year about mid-May. If the bush is pruned earlier in the year, the new growth dies back during the pre-monsoon drought. After pruning, little crop is obtained till October. During the second and third years the bush is in full bearing, but the crop tails off in the spring of the fourth year. Good areas will give half a maund of tea per acre in the year of pruning, by the end of that season; 5 mds. in the second, and 4½ mds. in the third year, the two last years being unpruned. It often happens that in an extra bad spring drought the one year wood dies back and a new frame has to be built up again.

The bushes are pruned up three times over a period of nine years, and they might go longer but for the fact that in this period there is practically certain to be an extra bad drought which kills the wood right back.

Here it is of interest to discuss whether Ranchi pruning methods might be adapted to some of the difficult areas in North East India. One garden near Jalpaiguri is pruned in May on account of the climate which is similar to, but not so severe as that in Ranchi. Before pruning, a spring flush of 2 or 3 mds. tea is taken and another vigorous flush is ready about six weeks after pruning. The devasting effect of the drought is thus avoided. Similar pruning is also being tried in the Terai and Western Dooars, not primarily on account of the climate, but as an attempt to avoid loss of crop by mosquito (*Helopeltis theivora*). It is considered that if the bush is flushing vigorously in September, as is the case with May pruning, it may push through a mosquito attack. At the same time the removal of the food supply of the pest at a critical period should assist in control.

The tea in Ranchi is plucked every eight days. The first plucking is at about 19″ from the ground on a low cut, and on 3 inches of new wood, *i.e.*, three leaves, on a top prune. In the second flush one leaf is left and in the third flush plucking is to the *janam*.

So far as cultivation is concerned in Ranchi, matters are easier than in North East India on account of much less vigorous weed growth. A soil mulch is essential in the dry season but even then it dries to a depth of about 18 inches. Drains do not appear to be needed in Ranchi tea gardens.

Shade is provided by the mango, toon (*Toona cedela*), sirris, sau (*Albizzia stipulata*) and many other trees. Boga medeloa, sunn hemp and cowpeas are used as green menures. Artificial manures are now being used extensively.

Pests and blights give little trouble in Ranchi and the wood of the bushes appears extraordinarily clean and free from parasitic growth. The severe drought no doubt reduces disease.

Tea Manufacture in Ranchi.

Practically all the leaf in Ranchi is made into green tea which brings a good price on the Calcutta market.

When the leaf is brought to the factory it is placed in a revolving wooden case into which steam is blown for about two minutes. By this means the leaf is killed and fermentation rendered impossible. Leaf brought in late in the afternoon is spread thickly in a cool place overnight and steamed in the morning.

When the steamed leaf is cooled somewhat it is put through a hydro-extractor to remove the superficial moisture, although during this process some of the leaf juices are also removed and a considerable amount of solid matter thus lost. This loss does not occur if the preliminary heating is done in a hot pan, which process is followed in some districts where green tea is made.

The leaf is next rolled for 35 minutes without pressure and then fired to "4-annas" dry. A moisture estimation on leaf

dried to this stage showed it to contain about 50% moisture. A second roll is then given, with pressure, for about 45 minutes after which the firing is continued. The leaf is finally fired in a Gibbs and Barry or Gibbs and Winsland machine. This type of machine consists of a long, revolving cylinder fitted with vanes and baffles. Hot air is passed into the cylinder through which the leaf gradually works its way, receiving some twist and its final drying.

The tea is polished by placing it in a steam-heated, revolving cylinder with powdered soap stone. Polishing is done for about 3 hours before and 5 hours after sorting.

Tea in Dehra Dun.

The Dehra Dun tea gardens are all situated in the *dun* or valley formed between the Himalayas and the Siwalik Hills. The Siwalik range stretches from the Brahmaputra to the Indus, except for a short distance of about 50 miles in the Bengal Dooars, between the Raidak and the Teesta. In places they are pressed against the Himalayas, as in the Bengal Terai, but in others they are separated from the main range by *duns*, which may be from 20 to 50 miles wide.

The formation of the Siwaliks is of interest. The central axis of the Himalayan range is buttressed on either side by an immense depth of sedimentary strata which has been washed down from the crest line by the action of seas and rivers. The whole of the Himalaya appears to have advanced southward and, as a result of this lateral thrust, the Siwaliks have risen. They are thus composed of the same material as that forming the level plains of North India and the Siwalik zone was formerly the northernmost belt of the great alluvial region.

The most recent deposits of stones and gravel have raised the level of the Dehra *dun* about 1,000 feet above the plains to the south of the Siwaliks. Dehra is about 2,000 feet above sea level. The Siwalik range rises to about 3,000 feet on the south side of the *dun* and the Himalayan foothills to 7,000-8,000 feet on the north.

Mussoorie is situated on the Himalayan foothills, above Dehra Dun, at an altitude of about 7,000 feet.

Dehra Dun is one of the historic areas in tea development in India. The Committee appointed by the Governor-General of India in 1833 to consider the question of tea growing in India recommended the lower hills and valleys of the Himalayas (indieating Mussoorie and Dehra Dun) as the most suitable place for tea cultivation. Accordingly, in 1840 a Government tea plantation was started at Kowlagarh, near Dehra Dun. In 1851, Robert Fortune, at that time the authority on tea in China, inspected Kowlagarh and reported unfavourably on the site and the tea and condemned irrigation, apparently on the ground that it was unnecessary in China. Present day experience in Dehra frequently shows that irrigation of tea is harmful on account of the alkalinity of the irrigation water.

The tea industry in Dehra Dun has developed alowly, with ups and downs parallel to those experienced in other parts of India. Today, tea in Dehra Dun is in a sound position and able to pay good profits.

The Dehra Dun tea soils.

The Dehra Dun tea soils are of an alluvial nature resembling in texture many of the Assam soils. They are well supplied with organic matter and plant food but have the very serious drawback, so far as tea is concerned, of lacking strong acidity. Although tea will grow on faintly acid or neutral soils, its developement is slow. For rapid growth and good crops, tea must be planted on acid soil showing a pH value of about 5.4. The Dehra Dun soils examined show pH values of 6.0 and over.*

Lack of acidity is common in soils round Dehra Dun and samples examined from many places in the *dun* and from the Sirmur and Nahan States all show this characteristic. Alkaline soils and soils showing only a faint acidity are common all along

* The acidity varies inversely as the pH value of the soil solution. Thus a soil solution with a pH of 5.4 is much more acid than one with a pH of 6. The Hopkins acidity value represents the lime required to neutralise a million parts of soil. This value varies directly as the acidity.

the foot of the Himalayas, and certain districts in the Dooars and the Darrang division of Assam include extensive areas of such soils. In such places the tea is usually poor, judging by standards in North East India.

The average nitrogen content of the Dehra Dun tea soils is 0.10%, the available phosphoric acid 0.01% and available potash about the same figure. The available lime shows a wide variations with limits at about 0.05% and 0.20%.

The table below shows the mechanical analysis of representative tea soils from Dehra Dun, together with acidity values.

Dehra Dun tea soils.

Garden.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ignition.	Hopkins acidity.	pH value.
	%	%	%	%	%			
Kowlagarh ...	15	26	35	7	12	5·16	14	...
Hurbanswala No. 4 ...	22	37	12	16	9	3·35	7	6·0
East Hoptown No. 4	18	38	19	14	7	4·58	7	6·2
Arcadia, light soil ...	11	19	28	23	10	5·93	7	6·0
„ loam ...	4	20	33	24	12	5·55	7	6·1
Annfield, loam ...	3	27	26	20	11	5·0	...	...
„ light soil ...	28	59	4	4	2	2·4	...	...

As in Ranchi, lime and alkaline manures must be avoided on Dehra Dun tea lands. Systematic and continuous manuring, which includes the addition of nitrogen in the acid form as sulphate of ammonia, would be well repaid in Dehra Dun.

Field methods in Dehra Dun.

The jat of tea grown in Dehra is generally China hybrid, but the Burma variety will also thrive. The average crop is about 450 lbs. per acre. Unlike in Ranchi, the gardens usually consist of consolidated areas of 250 or 500 acres, although several much smaller gardens exist.

In Dehra Dun excellent nurseries can be obtained under shade. If carefully tended, a percentage of infillings live.

Pruning is carried out annually from November to February. The general pruning cycle begins with a heavy prune, after

which the bush is left unplucked or lightly plucked during the following season. The next cold weather the bush is cut at 24 to 30 inches. Top pruning on about one inch of new wood is then practised for the next ten years or more, after which, when the crop falls off, the bush is heavy pruned again. This treatment produces frames with thin wood and little spread. If a bush is middle pruned there is a probability that it may die back. In some cases, however, middle pruning has given excellent frames comparable with those in Assam.

Plucking is carried out about every 12 days and a leaf is left at each plucking. The first plucking is made on about 4 inches of new wood.

The commonest and best shade in Dehra is the shishum (*Dalbergia sissoo*). The dhak or palas (*Butea frondosa*) and toon are frequently employed. The use of green crops is common and recently, artificial manures have been tried.

Pests and blights are not serious on tea in Dehra Dun, the salutary effect of the drought being apparently largely responsible for this freedom.

Manufacture in Dehra Dun.

Practically all the leaf in Dehra is manufactured into green tea which is usually sold at the garden factory to Indian merchants. When the price is fixed, the tea is packed into bags and taken off in lorries to Amritsar, where it is repacked for Kashmir and the Frontier. One or two breaks are sold each year on the Calcutta market by some of the bigger concerns.

In Dehra the preliminary sterlization of the leaf is carried out in pans heated to dull redness by wood fires. About 15 lbs. green leaf is thrown into the pan and kept stirred with a stick for 3 or 4 minutes. At the end of this time about 2½ lbs. moisture has been driven off and the leaf has turned an olive green. Hard or old leaf is burnt in the panning process or fails to take on the correct colour.

The leaf is then rolled for about half an hour and spread on cement in the sun to dry partially. During this time the leaf turns a greenish black colour. If there is no sun for drying, the leaf is put through a drying machine and dried just short of crispness. Another roll is then given, followed by a final fire.

The afternoon leaf is kept overnight before pan firing, and to ensure that it does not wither, is spread thickly in a cool place and watered if necessary.

The finished green tea is not polished in Dehra Dun.

Crop distribution.

In the light of what has been said regarding climate and methods in Dehra Dun and Ranchi, it is of interest to compare the crop distribution throughout the season in these districts with that in Assam. In addition the distribution on a garden near Jalpaiguri is also considered in the table below.

The spring crop in Ranchi, Dehra Dun and Jalpaiguri depends mainly on the early rain. The more reliable climate in Assam makes the early variation less distinct, but it is still very definite.

In considering distribution in Ranchi it must be remembered that one-third of the area is pruned in May. In Dehra the whole area is pruned in the cold weather. In the case of the garden at Jalpaiguri, about one quarter of the area was unpruned or the bushes lightly levelled with a pruning knife, and the remainder pruned in May. The unpruned section on this garden showed a big falling off in crop in May, after the early flush in March and April. The whole area in the case of the example from Middle Assam was pruned in the cold weather. With a part of the garden unpruned the crop percentage in the earlier months may, of course, be increased in Assam.

The following table shows the crop distribution in the four areas under consideration. The average monthly crop is expressed as a percentage of the total coop.

Crop distribution.

Months.	Ranchi.	Dehra Dun.	Jalpaiguri.	Middle Assam.
	%	%	%	%
January ...	...	...	...	...
February ...	1	...	...	...
March ...	6	1	5	...
April ...	16	20	12	2
May ...	6	7	5	4
June ...	7	3	9	11
July ...	16	15	10	15
August ...	15	21	18	20
September ...	14	17	14	20
October ...	13	11	13	19
November ...	5	5	10	9
December ...	2	...	4	...

EFFECT OF SPRAYING, OF TIME OF PRUNING, AND OF CLEANING OUT ON TEA CROP.

BY

H. R. COOPER.

These experiments were performed on tea collar pruned in 1924, unpruned in 1925, and cut back to 8″ in 1926. In 1929 therefore crop was rising too rapidly to allow very accurate measurement of the effects produced by difference in treatment.

The particular tea was selected because since cutting back to 8″ it has always been badly attacked by rim-blight, and it was desired to observe the effects of the treatments on this disease.

Unfortunately the combined effects of increasing maturity, and of a very favourable season kept all the tea practically free of disease in 1929, so that the experiment failed in its main object. The results, however, are sufficiently accurate to be worth record as indications of the probable effects of the differences in treatment on ordinarily healthy tea.

Experimental details are given in Appendix I.

The following were the results obtained :—

Treatment in 1929.

Spraying experiments. (All pruned December 20th and cleaned out).

	Yield mds. tea per acre.	
	1928. (All under same treatment.)	1929.
Sprayed with Lime Sulphur	6·90	9·71
,, ,, Nicotine	6·90	9·31
,, ,, Nicotine and Lime Sulphur ...	6·91	9·57
,, ,, Bordeaux mixture	6·86	9·79
No spraying	6·92	9·62

Pruning experiments (no spraying).

	Yield mds. tea per acre.	
	1928. (All under same treatment.)	1929.
Pruned December 20th 1928 Cleaned out ...	6·92	9·62
„ February 20th 1929 „ ...	6·93	8·23
„ March 20th 1929 „ ...	6·95	6·95
„ December 20th 1928 Not Cleaned out ...	6·93	9·35
„ March 20th 1928 „ ...	6·89	6·75

Spraying. All the sprays were applied immediately after the pruning was finished, and again on March 2nd when the new growth was well away.

It will be observed that crops are practically the same whether the tea was unsprayed or sprayed with lime sulphur, Bordeaux mixture, or with the mixture of lime sulphur and nicotine. The spraying with nicotine alone appears to give a reduced crop. It is possible that the nicotine exercised a slight poisoning effect, on the bush and so reduced crop : but it is doubtful whether this apparent loss is really significant and not due merely to experimental error. That the spraying showed no beneficial result is somewhat disappointing : but the failure to obtain results was due merely to the fact that so little disease was present on any of the plots that it did not affect crop appreciably. This experiment, however, is useful in establishing the fact that it is useless to spray normally healthy tea. No stimulant effect appears to be obtained from application of any of the spray fluids.

PRUNING.

Effect of Time of Pruning.

The effect on crop of difference in time of pruning was very marked.

	Crop 1929.	Loss from late pruning.
In the case of tea which was cleaned out,		
	Mds.	Mds.
Pruning on December 20th 1928 gave ...	9·62	...
„ „ February 20th 1929 gave ...	8·23	1·39
„ „ March 20th 1929 gave	6·95	2·67
In the case of the tea not cleaned out,—		
	Mds.	Mds.
Pruning on December 20th 1928 gave ...	9·35	...
„ „ March 20th 1929 gave	6·75	2·60

These losses are very significant. Each treatment was repeated on seven plots which were in fair agreement, and the appearance of the tea (particularly in the early half of the season) in each case corresponded with the yields obtained. The tea pruned in March looked very poor till late in the season.

This tea was planted at the end of 1921, collar pruned October 1923, and unpruned in 1925 when it gave 10 mds. per acre. In 1926 after cutting back to 8″ it showed rim-blight badly in the spring which persisted in the spring of 1927 and was extremely bad in 1928, though the tea always looked very well by the end of July. During this time it was very lightly plucked and grew thick wood. Although on one year wood, the pruning at 18″ from the ground before the 1929 season was therefore a relatively heavly prune, and the plucking was over long growth.

On ordinary top-pruned tea leaving 6″ or 8″ new growth, losses from late pruning probably would not be so great. On heavy pruned tea the relative losses probably would be even greater. From general observation it would appear that loss will always occur if tea is pruned at the time of active spring growth. The period from March to May appears to be a particularly bad time in which to prune; while even February pruning, though generally it cannot be avoided may be expected to give worse results than pruning in the "resting period" of December-January.

It is true that late pruned bushes may avoid red spider attack. In this experiment the earlier pruned bushes showed more red spider in the spring; but the bushes came through and the loss from red spider was much less than the loss from late pruning.

The losses from late pruning of course were greatest during the early months of the year; but the later pruned plots gave smaller crops throughout the season. Even in October and November crops were slightly less from the later than from the earlier pruned tea. There was no gain in late season tea from the later pruning, as is sometimes supposed would be the case.

Effect of Cleaning out.

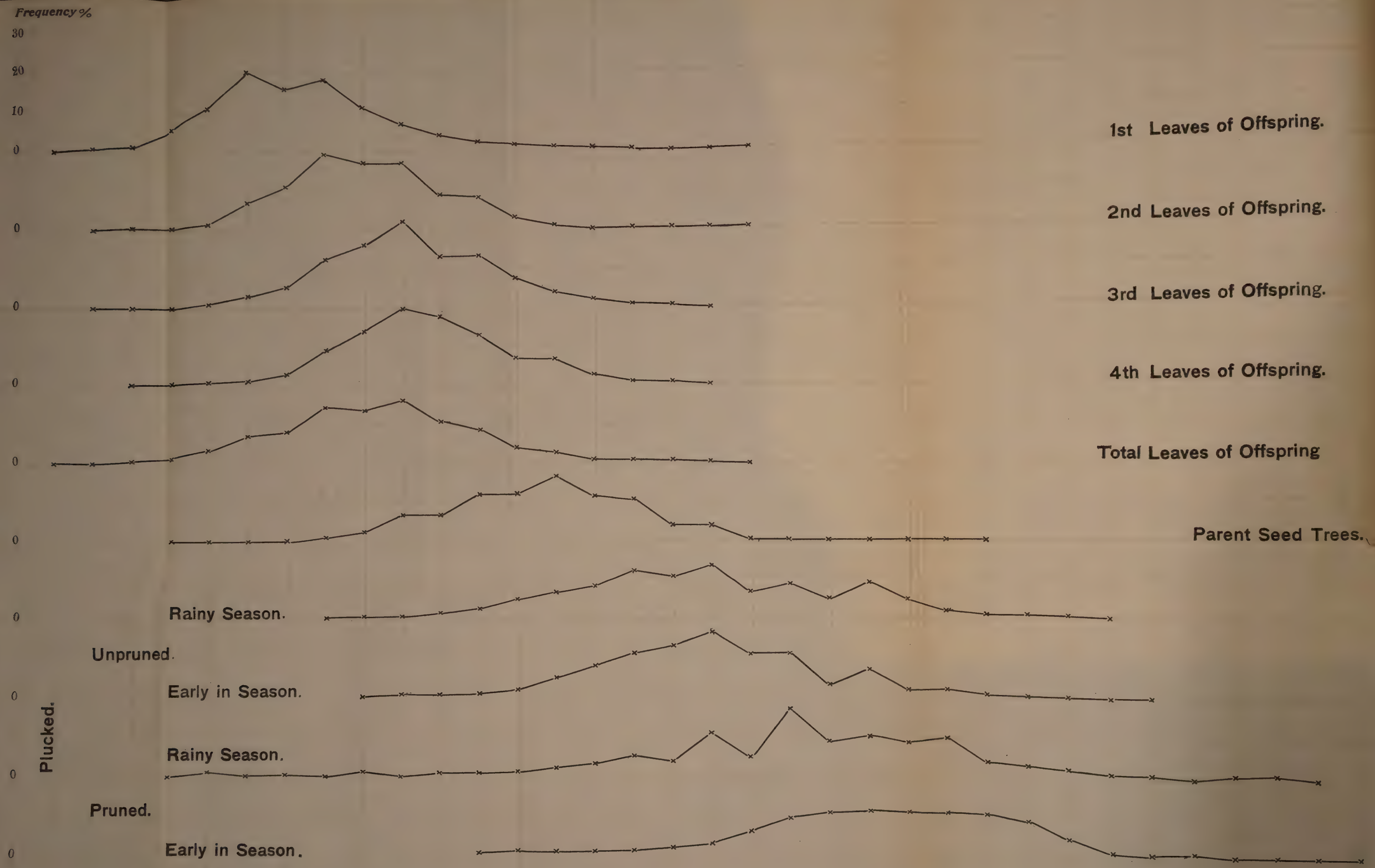
	Cut at 18″ from ground bad wood and banjhi twigs cut out.	Cut across at 18″ from ground and nothing taken out.
	Mds.	Mds.
December pruning	9·62	9·35
March „	6·95	6·75

In both the above cases the tea not cleaned out has given a slightly smaller crop than the corresponding cleaned out tea. The differences, however, are so small that it is doubtful whether they may not be due to the unavoidable error of the experiment.

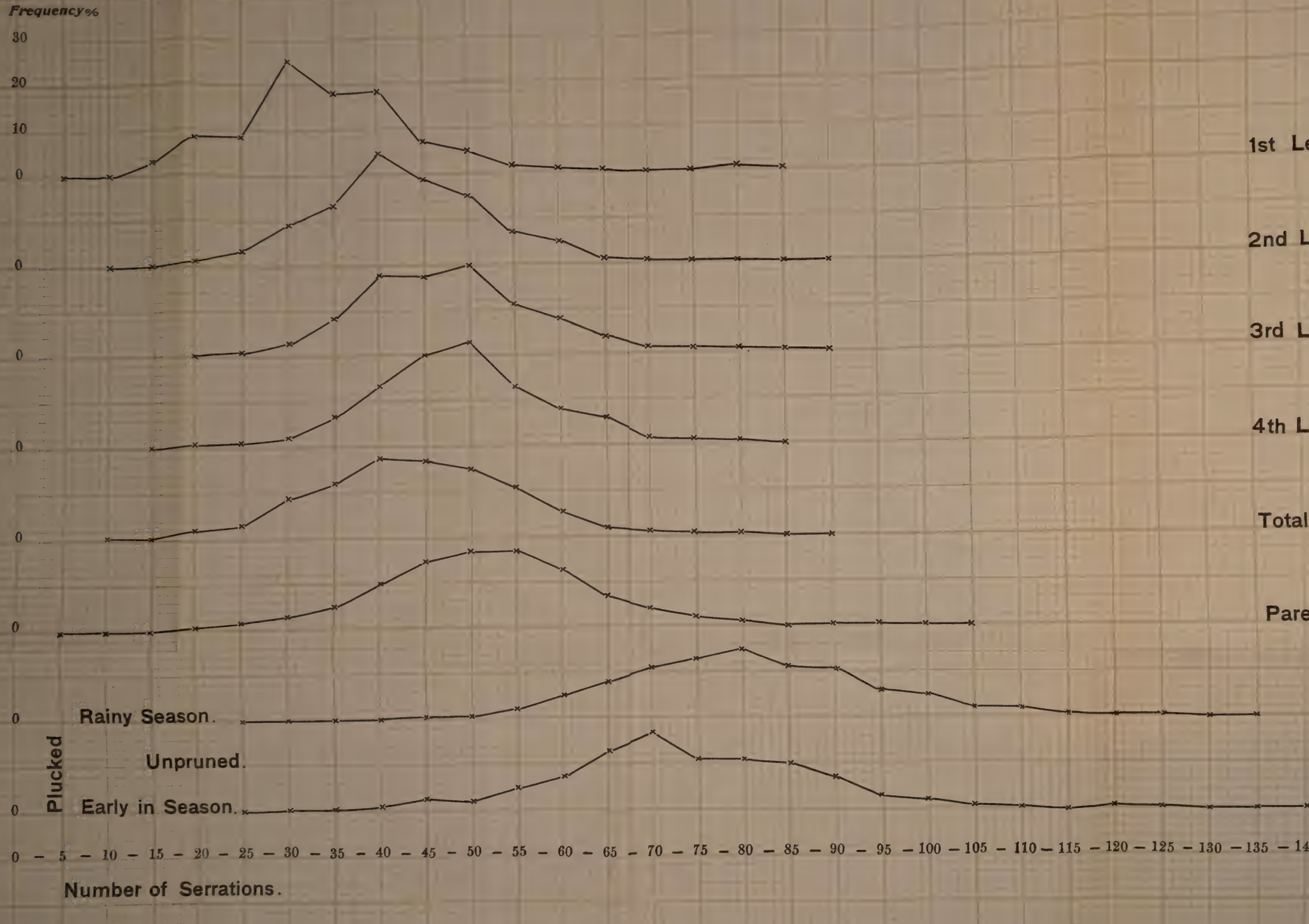
This particular tea had in previous years been well but not immoderately cleaned out, and plucked over long growth. From general experience it is believed that failure to clean out under these conditions would have produced just such almost negligibly small losses of crop as were obtained in this experiment. On ordinary top-pruned mature bushes, plucked over 6″ or 8″, the loss from failure to clean out for one year would probably be more significant, though still small. On bushes badly in need of cleaning out, much greater losses may be expected from failure to do it.

In Appendix II are recorded the results of regular observations on the amount of disease present.

ASSAM TYPE.


Frequency %
30
20
10
0
1st Leaves of Offspring.
2nd Leaves of Offspring.
3rd Leaves of Offspring.
4th Leaves of Offspring.
Total Leaves of Offspring
Parent Seed Trees.
Rainy Season.
Unpruned.
Early in Season.
Rainy Season.
Pruned.
Early in Season.
Plucked.
0 – 5 – 10 – 15 – 20 – 25 – 30 – 35 – 40 – 45 – 50 – 55 – 60 – 65 – 70 – 75 – 80 – 85 – 90 – 95 – 100 – 105 – 110 – 115 – 120 – 125 – 130 – 135 – 140 – 145 – 150 – 155 – 160 – 165 – 170
Number of Serrations.

BURMA TYPE.


Frequency %
30
20
10
0
0
0
0
0
0
Plucked
Rainy Season.
Unpruned.
Early in Season.
0 – 5 – 10 – 15 – 20 – 25 – 30 – 35 – 40 – 45 – 50 – 55 – 60 – 65 – 70 – 75 – 80 – 85 – 90 – 95 – 100 – 105 – 110 – 115 – 120 – 125 – 130 – 135 – 140 – 145 – 150 – 155 – 160 – 165 – 170.
Number of Serrations.
1st Leaves of Offspring.
2nd Leaves of Offspring.
3rd Leaves of Offspring.
4th Leaves of Offspring.
Total Leaves of Offspring.
Parent Seed Trees.

APPENDIX I.

Experimental details.

For this experiment 14 plots of tea were used, each being divided into 5 sub-plots. All the sub-plots contained 90 bushes occupying about 1/25 acres) except sub-plot 204 E which contained 63 bushes. In the tables following the yields of all sub-plots are recorded as lbs. green leaf per 90 bushes, the actual yield from sub-plot 204 E being multiplied by 10/7.

Yields in 1928 before treatment show that the natural yielding capacity falls off fairly regularly from plot 204 to plot 217; and in the cross direction from A to E. While plot 204 gave over 73% more than plot 217, the average of the A sub-plots was only 11% more than the average of the E sub-plots. The area was therefore divided into seven blocks of two plots each, so that the yields of the ten sub-plots within each block differed as little as possible among themselves.

The 70 sub-plots were then divided into 10 series of 7 sub-plots each, selected so that the sums of the yields of the 7 sub-plots in each series were practically the same in 1928, when all sub-plots were treated alike.

It was arranged also that each block of ten sub-plots contained one sub-plot of each series.

The experiments were originally intended to determine the effects of difference in treatment on rim-blight, which had always affected these plots seriously; and the experiment was designed as much for observation as for measurement of yield.

The tea pruned in December and not sprayed was taken as the standard for comparison, and in order that sub-plots of tea under each other treatment should not be far from this standard, two series (14 sub-plots) were devoted to this treatment.

Table I gives the yields obtained from each sub-plot.

The 1929 yields from sub-plots of Series 3, 4, and 6 have clearly been affected by the treatments given in 1929. The other 49 sub-plots have not been very greatly affected by difference in treatment, if at all. The increases in crop from these 49 sub-plots vary between 11 lbs. and 51 lbs., the average being 31 lbs. 41 increases lie between 22 and 40, while 16 lie between 29 and 31.

The increases are thus very irregular, which might be expected since both the 1928 yields and the 1929 yields are subject to experimental error. Yet it appears that these increases represent the best means of estimating the measure of agreement between yields from plots under the same treatment.

Of the 1928 yields only three are above 100, and four below 60 lbs.

The following table shows the average increases made by plots of different initial yield.

Yield 1928.	Average increase in 1929.
Over 90 lbs.	30 lbs.
80 to 90 lbs.	30 lbs.
70 to 80 lbs.	33 lbs.
under 70 lbs.	33 lbs.

It is clear from these figures that the natural increase in 1929 is not proportional to the previous year's yield. In fact there is a tendency for the poorer plots to increase faster than the better plots (that is, there is a tendency for the plots to even up) but it appears that the increases per plot should be approximately equal, apart from differences due to experimental error or to effect of treatment.

Table II shows the increase in crop from each sub-plot (to the nearest lb.) in 1929 compared to 1928.

SERIES No. 2

	1	2	3	4	5	6	7	8	9	10
Block No. 1	+29	+25	+ 6	− 7	+40	−20	+28	+23	+18	+32
" " 2	+29	+33	− 2	+ 5	+11	− 8	+31	+24	+40	+39
" " 3	+36	+29	+22	− 3	+19	+ 3	+30	+31	+30	+26
" " 4	+41	+31	+20	+ 6	+31	+ 4	+54	+22	+34	+35
" " 5	+31	+39	+13	+ 1	+17	+ 1	+29	+34	+39	+25
" " 6	+33	+24	+18	− 1	+37	+ 5	+31	+37	+29	+51
" " 7	+29	+29	+28	...	+43	+ 3	+26	+25	+27	+29
Average gain per sub-plot	+32	+30	+15	0	+28	− 2	+32½	+28	+31	+34
Probable error of mean	±1·1		±2·6	±1·1	±3·0	±2·2	±2·4	±1·5	±1·9	±2·2

Series 1 and 2 received the same treatment.

Of the sprayed series 7, 8, 9 and 10, series 9 makes the same increase as the unsprayed but otherwise similarly treated series 1 and 2. The apparent benefit from the spraying of series 7 and 10 is not sufficiently great, nor is the apparent loss from the spraying of series 8, sufficiently great to be considered definitely significant. Series 5, which was pruned at the same time as series 1 and 2 but was not cleaned out, shows an apparent reduction of crop which is not significant.

Series 3, compared to series 1 and 2, shows a significant reduction of crop due to pruning in February instead of December.

Both series 4 and 6 show still greater significant losses compared to series 5 from pruning in March instead of February.

Series 4 was cleaned out; series 6 was not. Series 6 shows an apparent loss compared to series 4, but the difference is not significant within the limits of the error of the experiment.

TABLE I.

Crops in lbs. & ozs. green leaf per 90 bushes.

	Series 1. Pruned December cleaned out not sprayed.		Series 2. Same as Series 1.		Series 3. Pruned February cleaned out not sprayed.		Series 4. Pruned March cleaned out not sprayed.		Series 5. December pruned not cleaned out not sprayed.	
	1928.	1929.	1928.	1929.	1928.	1929.	1928.	1929.	1928.	1929.
Block 1 ...	111-7	140-0	99-5½	124-6	109-13½	115-9½	108-0½	107-0	98-11	138-14
Block 2 ...	82-15	111-12	92-4½	124-14	83-9	81-12	88-6	93-1	92-14	103-14
Block 3 ...	82-4	118-1	77-10	107-1½	72-5½	94-0	80-3	77-0½	86-8	105-3
Block 4 ...	70-5	100-15	85-4½	116-7	70-13½	90-10	78-3	83-13	77-14	108-14
Block 5 ...	81-7	122-12	73-0	112-8	79-4½	91-12½	74-2	75-1	77-4½	94-5
Block 6 ...	70-3	103-9½	80-4½	104-4	63-4½	81-9	67-11	66-6	61-10½	98-11
Block 7 ...	64-4½	93-7	53-11	82-9½	83-14	112-14½	68-1	67-14½	65-13½	109-3½
Total ...	562-13½	790-8½	561-8	772-2	563-0½	668-3½	564-10½	564-5½	563-7	759-0½

TABLE I.—(*continued*).

B.	Series 6. Pruned March not cleaned out not sprayed.		Series 7. Pruned December cleaned out sprayed with Lime-sulphur.		Series 8. Pruned December cleaned out sprayed with nicotine.		Series 9. Pruned December cleaned out sprayed with nicotine and Lime-sulphur.		Series 10. Pruned December cleaned out sprayed with Bordeaux mixture.	
	1928.	1929	1928.	1929.	1928.	1929.	1928.	1929.	1928.	1929.
Block 1 ...	103-13	83-11	109-0	137-1	92-14	115-14	113-0	130-9	96-11	128-9
Block 2 ...	90-5	81-14	83-3½	114-4	98-11	123-1	79-8	120-2½	91-3	130-1½
Block 3 ...	76-15	50-4	70-6	99-14	86-8	117-15	74-9	104-10	81-0	106-12½
Block 4 ...	74-4	77-12	91-1	144-14	77-14	99-15	87-6	121-6	78-10	113-3½
Block 5 ...	80-14	81-13	81-2	110-0	77-4½	110-0	81-15	120-13	86-6½	111-11
Block 6 ...	78-3	83-0	74-6	104-4	61-10½	98-8	67-15½	95-8½	68-8	119-12
Block 7 ...	55-14	59-10	51-12	77-14	65-13½	90-13½	57-2½	84-3	55-9	84-11½
Total ...	560-4	548-0	560-14½	788-13	560-11½	756-2½	561-8	777-8	557-15½	794-13

APPENDIX II.

Note on effects of Spraying, and of Differences in Pruning on degree of attack by disease.

BY

A. C. TUNSTALL.

At intervals throughout the year careful observations on the aphis, red spider, rim-blight and commoner blights (red rust, brown and grey blights) were made by the Mycological Branch. The presence of any of these blights on a bush was recorded whether the blight concerned was doing any apparent damage or not. Very few bushes were attacked sufficiently severely to cause any decrease in crop capable of measurement. The degree of infection has been worked out as follows :—

A bush which has ceased flushing on account of disease has been recorded as 100 while a bush which is very slightly attacked has been recorded as 1; intermediate cases being marked in proportion to the damage done. By adopting these figures it is assumed that at the time of the attack the slightly attacked bush is losing 1% of its crop for the duration of the attack. As in few cases the attack persisted more than two months and the plucking season lasts for 8 or 9 months the annual loss in crop of a bush recorded as 1 for two months would be not more than 25%. If all the bushes in a plot (90) were slightly attacked this would be recorded as 90 in the following tables but it would only mean a reduction of crop of 1% at the time of recording—a negligible quantity in the total. On none of plots were all the bushes even slightly affected at any one time during the period of the experiment. From the point of view of the effect of spraying on crop therefore the figures recorded below are of little value. Such figures are not likely to be useful unless the attacks of pests and blights happen to be severe.

The results of the spraying under the conditions of the experiment can only be temporary as the spraying plots are of

necessity surrounded by unsprayed ones. The new leaf formed after the application of spray fluid is unprotected and would become reinfected from the unsprayed plots. In the case of a severe attack it would be possible to measure the temporary improvement following the spraying.

Series.	1	2	3	4	5	6	7	8	9	10
Treatment.	Clean pruned in Dec. 1928. Check.	Clean pruned in Dec. 1928. Check.	Clean pruned in Feb. 1929.	Clean pruned in Mar. 1929.	Cut across in Dec. 1928.	Cut across in Mar. 1929.	Clean pruned in Dec. 1928. Lime sulphur spray.	Clean pruned in Dec. 1928. Nicotine spray	Clean pruned in Dec. 1928. Lime sulphur and Nicotine spray.	Clean pruned in Dec. 1928. Bordeaux mixture spray.
Date	Degree of infection.									
	Tea aphis.									
25-27·2 ...	69·1	56·2	0·5	0	28·5	0·42	55·6	51·2	44·8	72·5
12-15·3 ...	83·0	79·0	78·1	35·7	69·1	22·7	82·1	75·4	82·0	82·7
9-11·4 ...	0·1	0·1	2·6	9·8	0	9·8	0·1	0	0 1	0
24-26·4 ...	0	1·4	0·5	7·5	0	6·2	0	0·28	0·16	0
8-10·5 ...	1·8	1·8	4·1	27·2	1·6	16·4	1·0	1·8	3·3	0·4
27-29·5 ...	0	0	0·3	0	0	0	0	0·1	0	0
13-15·6 ...	0	0	0·1	0	0	0·14	0	0	0	0
26-28·6 ...	0	0	0	0	0	0	0	0	0	0
24-26·7 ...	0	0	0	0	0	0	0	0	0	0
2-4·9 ...	0	0	0	0	0	0	0	0	0	0
30·9 to 3·10	0·33	0	0	0·14	0·5	0·57	0·66	0	0·5	0·14
4-6·11 ...	6·3	8·8	5·6	12·7	9·5	5·1	12·1	8·7	11·6	8·1
2-4·12 ...	0	0·42	1·0	0·28	0·33	0·57	0·33	1·0	0·5	0·57
	Red spider.									
25-27·2 ...	0	0	0	0	0	0	0	0	0	0
12-15·3 ...	0	0	0	0	0	0	0	0	0	0
9-11·4 ...	0	0	0	0	0	0	0	0	0	0
24-26·4 ...	0	0	0	0	0	0	0	0	0	0
8-10·5 ...	44·0	44·0	10·0	4·4	61·5	17·4	20·3	51·6	18·0	33·5
27-29·5 ...	34·3	35·0	13·3	7·8	42·7	16·4	11·0	33·6	18·1	24·6
13-15·6 ...	19·6	19·1	4·3	2·8	28·0	5·7	4·3	19·8	6·5	12·1
26-28·6 ...	12·5	14·5	2·5	1·1	16·8	4·0	2·5	10·4	3·8	7·0
24-26·7 ...	0	0	0	0	0	0	0	0	0	0
2-4·9 ...	3·3	9·8	1·1	1·7	2·1	5·8	11·5	4·0	8·8	7·2
30·9 to 3·10	15·0	19·5	9·3	7·4	15·3	15·2	24·1	14·5	23·5	21·0
4-6·11 ...	1·3	10·1	2·3	1·0	3·1	3·8	11·6	3·2	10·8	5·7
2-4·12 ...	0·6	0·28	0·33	0·14	0	0·14	0	0·42	0	0·28

Series.	1	2	3	4	5	6	7	8	9	10
Treatment.	Clean pruned in Dec. 1928. Check	Clean pruned in Dec. 1928. Check.	Clean pruned in Feb. 1929.	Clean pruned in Mar. 1929.	Cut across in Dec. 1928.	Cut across in Mar. 1929.	Clean pruned in Dec. 1928. Lime sulphur spray.	Clean pruned in Dec. 1928. Nicotine spray.	Clean pruned in Dec. 1928. Lime sulphur and Nicotine spray.	Clean pruned in Dec. 1928. Bordeaux mixture spray.
Date.	Degree of infection.									
	Rim-blight.									
25-27·2 ...	0·5	0·14	0	1·4	0	1·0	0	0·28	0·5	0·14
12-15·3 ...	8·0	9·2	0	3·8	4·8	4·1	7·8	7·1	7·6	6·5
9-11·4 ...	32·1	35·1	23·3	11·4	22·8	20·4	34·1	32·0	34·3	30·8
24-26·4 ...	46·5	36·2	36·1	12·7	30·1	26·5	56·1	45·1	62·1	44·2
8-10·5 ...	34·1	34·1	40·8	17·4	15·3	23·1	47·8	38·6	48·0	37·4
27-29·5 ...	19·3	15·1	22·3	10·7	19·8	20·7	18·3	10·5	17·1	12·7
13-15·6 ...	0	0	0·33	0·28	0	0·28	0	0·14	0·16	0·28
26-28·6 ...	0	0	0	0	0	0	0	0	0	0
24-26·7 ...	0·33	0	0·16	0·14	0	0	0·43	0	0	0
2-4·9 ...	0·3	0·14	0·16	0·14	0	0·42	0·66	0	0	0·14
30·9 to 3·10	0·16	0·28	0·5	0	0	0·14	1·0	0·14	0	0
4-6·11 ...	0·83	0·57	0·16	0·14	0·83	0·71	0·5	0	0·33	0·42
2-4·12 ...	0	0·14	0	0	0·16	0	0·16	0·28	0·16	0·28
	Common blights—Principally Brown blight but including Grey blight and Red rust									
25-27·2 ...	0	0	0	0	0	0	0	0	0	0
12-15·3 ...	0	0	0	0	0	0	0	0	0	0
9-11·4 ...	1·3	2·0	0·3	0	4·3	0	1·8	1·8	3·0	1·2
24-26·4 ...	1·5	3·0	1·6	0·5	4·0	2·0	1·0	1·4	1·3	1·1
8-10·5 ...	14·5	14·5	6·6	2·5	30·3	11·8	12·6	12·4	10·5	13·2
27-29·5 ...	50·8	50·0	48·8	30·5	60·2	43·2	58·8	51·2	57·6	47·7
13-15·6 ...	56·0	62·8	71·5	43·4	79·1	66·0	65·3	59·7	59·3	54·4
26-28·6 ...	52·3	55·4	51·3	37·7	75·1	57·5	58·1	50·4	45·8	48·1
24-26·7 ...	62·3	61·7	49·1	35·2	75·3	49·1	57·1	62·4	56·3	53·2
2-4·9 ...	73·0	73·2	52·3	42·0	77·5	54·5	73·5	70·1	68·8	65·0
30·9 to 3 10	83·0	83·0	69·1	44·5	80·8	53·0	77·6	76·5	82·0	71·8
4-6·11 ...	62·5	70·0	38·8	26·5	69·5	34·4	59·5	70·0	62·1	58·8
2-4·12 ...	4·0	40·4	22·8	18·8	4·0	16·2	31·3	35·0	28·1	30·7

In spite of the very slight infection it is apparent in the above figures that there is a distinct reduction in the amount of red spider on the plots sprayed with Lime Sulphur compared with the check plots. Bordeaux mixture has some effect on red spider, while the nicotine appears to have had none. In the case

of other blights and pests no effect is apparent in any case. In regard to red spider it is interesting to note that the effect of Lime sulphur solution is still apparent, four months after the last application of the fluid when the pest disappeared from all the plots. This pest reappeared on all plots two months later, but the effect of the spraying was then no longer noticeable.

The figures show differences in the amount of infection on the plots pruned at different times. The plots pruned in March are less seriously attacked than those pruned earlier. This is particularly noticeable in the case of red spider. In regard to the influence of style of pruning, except in the case of tea aphis, the clean pruned series were less affected than the series merely out across at the same time.